

D E C L A R A T I O N

In the matter of U.S. Patent  
Application Ser. No. 09/866,773  
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I, Kumi HIRANO, of Kyowa Patent and Law Office, 2-3,  
Marunouchi 3-Chome, Chiyoda-Ku, Tokyo-To, Japan, declare  
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I further declare that all statements made herein of  
my own knowledge are true and that all statements made on  
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Date of Application: May 30, 2000

Application Number: Patent Application No. 2000-160940

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May 18, 2001

Commissioner,  
Patent Office

Kozo OIKAWA

Certificate No. 2001-3041367

Name of Document: Patent Application

Reference Number: K12-002

Application Date: May 30, 2000

To: The Commissioner of The Patent Office

International Patent Classification: G06T 1/00

Title of the Invention: INTEGRATED VIEW SYSTEM

Number of Claims: 6

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List of Documents filed:

Specification	1
Drawing(s)	1
Abstract	1
Number of General Power of Attorney	9006595
Proofreading	Needed

[Title of Invention]    INTEGRATED VIEW SYSTEM

[Claims]

[Claim 1]

An integrated view system comprising:

a stereo-camera installed in a vehicle for taking images of predetermined outside area;

a stereo-image recognizer for processing a pair of images taken by the stereo-camera to recognize objects that are obstacles to the front, thus generating obstacle data;

an integrated view data generator for generating integrated view data including three-dimensional view data based on the pair of images taken by the stereo-camera and the obstacle data from the stereo-image recognizer; and

an integrated view displaying means for displaying the integrated view data as visible images to crews on the vehicle.

[Claim 2]

The integrated view system according to claim 1, the peripheral wide-area view data is added to the three-dimensional view data.

[Claim 3]

The integrated view system according to claim 1 or 2, wherein the integrated view displaying means is a head mount display for overlapping the visible images of the integrated view data and actual view.

[Claim 4]

The integrated view system according to claim 3, wherein the integrated view data generator is capable of removing the three-dimensional view data by the stereo-camera depending on the instruction inputs.

[Claim 5]

The integrated view system according to any one of claims 1 to 4 wherein the stereo-camera is composed of the two infrared cameras arranged as separated from each

other by a distance corresponding to a specific base line.

[Claim 6]

The integrated view system according to any one of claims 1 to 4 further comprising multiple stereo-cameras, which are either an infrared camera, a milli-wave camera or an intensifier, different one another, and selectively used in accordance with actual views.

[Detailed description of the invention]

[0001]

[Technical Field]

The present invention relates to an integrated view system that provides crews on vehicle with views of high visibility even at actually low visibility.

[0002]

[Background Art]

Vehicles, for example, aircraft are provided with a view system having image sensors such as an infrared camera, a milli-wave radar and a laser radar. The view system offers a driver or pilot with artificial pseudo-views generated based on view data collected by the image sensors at low visibility at night or in bad weather and three-dimensional (three-dimensional) map data stored in the system for safety.

[0003]

Japanese-Unexamined Patent Publication No. 72350/1999 discloses generation of pseudo-views using wide-area geographical data based on three-dimensional map stored in memory and data on obstacles such as high-voltage electrical power lines, skyscrapers and cranes and displaying pseudo-views and actual views overlapping with each other on a transparent-type display mounted on a helmet of a pilot.

[0004]

[Problems to be resolved by the invention]

View data collected by the image sensors such as an infrared camera, a milli-wave radar and a laser radar are, however, not sufficient for a driver or pilot. Moreover, three-dimensional map data cannot follow actual changing geographical conditions. Pseudo-views generated based on these data therefore do not meet the requirements of a

driver or pilot.

[0005]

In detail, infrared cameras can be used at certain level of low visibility, particularly, can generate extremely clear images at night, however, lack in reality, perspective and feeling of speed due to monochrome images. Milli-wave radars can cover relatively long range even in rainy weather, thus useful in image displaying at low visibility, however, cannot generate clear images due to wavelength extremely longer than light, thus not sufficient for a driver or pilot. Laser radars have an excellent obstacle detecting function, however, take long for scanning a wide area, thus revealing low response. For a narrow scanning area, they provide relatively clear images, but, narrow views for a driver or pilot, thus not sufficient for safety.

[0006]

Generation of images of scenery in wide range of sight which could be viewed by a driver or pilot is useful. Such image generation requires decision of degree of risk of collision based on comparison among geographical data, obstacle data and vehicle positional data (longitude, latitude and altitude). These data, however, may not match actual land features and obstacles. Such image generation thus has a difficulty in covering newly appearing obstacles and requires a lot of confirmation of safety.

[0007]

The present invention has been made considering the situations shown above. A purpose of the present invention is to provide an integrated view system that offers crews on a vehicle with almost real pseudo views at high visibility like in a good weather even at low visibility with detection of obstacles to the front for safe and sure flight or driving.

[0008]

[Means of solving the problems]

For the purposes shown above, claim 1 of the present invention provides an integrated view system comprising: a stereo-camera installed in a vehicle for taking images of predetermined outside area; a stereo-image recognizer for processing a pair of images taken by the stereo-camera to recognize objects that are obstacles to the front, thus generating obstacle data; an integrated view data generator for generating integrated

view data including three-dimensional view data based on the pair of images taken by the stereo-camera and the obstacle data from the stereo-image recognizer; and an integrated view displaying means for displaying the integrated view data as visible images to crews on the vehicle.

[0009]

In claim 2, the integrated view data generator of claim 1 adds the peripheral wide-area view data to the three-dimensional view data by the stereo-camera.

[0010]

In claim 3, the integrated view displaying means in claim 1 or 2 is the transparent-type head mount display for overlapping the visible images of the integrated view data of the integrated view data generator and actual view.

[0011]

In claim 4, the integrated view data generator of claim 3 is capable of removing the three-dimensional view data from the stereo-camera depending on the instruction inputs.

[0012]

In claim 5, the stereo-camera in any one of claims 1 to 4 is the two infrared cameras arranged as separated from each other by a distance corresponding to a specific base line.

[0013]

In claim 6, the multiple stereo cameras in any one of claims 1 to 4 are installed, either an infrared camera, a milli-wave camera or an intensifier, different from one another and selectively used in accordance with actual views.

[0014]

In claim 1 of the present invention, a stereo-camera is installed in a vehicle, the integrated view data are generated by the three-dimensional view data processed by a pair of the images taken by the stereo-camera and the obstacle data processed by a pair of images taken by the same stereo-camera, and displayed as visible images to crews on the vehicle.

[0015]

In claim 2, the peripheral wide-area view data is added to the three-dimensional



view data view data by the stereo-camera. In claim 3, the transparent-type head mount display that can overlap the integrated view data and actual views is used. In claim 4, it is possible to remove the three-dimensional view data from the stereo-camera, and selectively overlap the integrated views including obstacle data obtained by removing the three-dimensional view data from the actual views, and the integrated views including the three dimensional data and obstacle data. In claim 5, the stereo-camera is configured by the two infrared cameras arranged as separated from each other by a distance corresponding to a specific base line. And in claim 6, the multiple stereo cameras, either an infrared camera, a milli-wave camera or an intensifier, different from one another and selectively used in accordance with actual views.

[0016]

[Detailed Description of Preferred Embodiments]

Preferred embodiments according to the present invention will be disclosed with reference to the attached drawings. Fig. 1 and 2 relate to one embodiment of the present invention. Fig. 1 shows a block diagram of an integrated view system according to the present invention. Fig. 2 illustrates displaying zones.

[0017]

An integrated view system 1 shown in Fig. 1 is installed in a vehicle such as an automobile, a train, and an aircraft. The system 1 offers integrated views to a driver or pilot generated as visible images of virtual reality at high visibility like in good weather even though actual visibility is very low in bad weather due to mist or fog, or at night. Disclosed hereinafter is an embodiment in which the integrated view system 1 is installed in an aircraft such as a helicopter that flies at relatively low altitude.

[0018]

The integrated view system 1 is provided with a stereo-camera 2 for taking images of forward scenery of a predetermined area, an image combining apparatus 10 and an integrated view displaying apparatus 20 as main components.

A pair of left and right images taken by the stereo-camera 2 is displayed on left and right viewing points of a pilot to generate three-dimensional (three-dimensional) images giving perspective and feeling of altitude and speed to the pilot. Moreover, the

pair of left and right images is processed by stereo-image processing for calculation of data on (relative) distance to objects. The image and distance data are processed by image recognition processing for displaying obstacles as warning when the obstacles are detected on or in the vicinity of flight route. The integrated view system 1 is provided with a sight-axis switch 3 for varying an axis of sighting by which the stereo-camera 2 turns into the direction required by the pilot or other crews, a display-mode switch 4 for controlling the stereo camera 2 to halt displaying three-dimensional images, and flight data interface 5 for entering flight data such as speed, altitude, position and attitude of a helicopter.

[0019]

The sight-axis switch 3 is useful to know beforehand the conditions of flight route to which the helicopter is to turn into or determine whether there is any obstacle on the route. The switch 3 in this embodiment is a manual switch to manually rotate the optical axis of the stereo-camera 2. Not only this, the stereo-camera 2 can be automatically turned into any direction by detecting pilot's viewing point by a head-motion tracker 23, etc., which will be described later.

[0020]

The stereo-camera 2 in this embodiment consists of two infrared cameras for generating extremely clear images particularly at night. The two infrared cameras are arranged with an optimum distance (base-line length) within an allowable range based on search range and distance accuracy for accurately detecting obstacles predicted under several flight conditions. Flight conditions under which a pilot requires support of artificial view at general low visibility mostly include night flight or other flight very close to this. Infrared cameras having an excellent night view function are useful in such conditions. Particularly, three-dimensional images generated by two infrared cameras offer virtual reality to a pilot with perspective and feeling of altitude and speed which cannot be achieved by a single infrared camera. Other flight conditions can be covered by several types of image sensors such as an ordinary camera, an intensifier that responses faint light, active/passive milli-wave cameras exhibiting excellent transparency to mist and rain and sensitive CCDs, other than infrared cameras. These sensors can be

selectively combined in accordance with cause of low visibility. It is also possible to select multiple types of cameras or image sensors depending on conditions.

[0021]

When relatively light-weight image sensors are used for cameras of the stereo camera 2, the base-line length for the stereo-camera 2 can be set by shifting both or either of cameras with the image sensors. Heavy image sensors can be fixed with an objective lens mechanism installed in a tube of a periscope, the tube-length being variable for varying the base-line length.

[0022]

In particular, the image combining apparatus 10 is provided with a stereo-image recognition processor 11 for recognizing obstacles by processing left and right images from the stereo camera 2, a geographical image generator 12 for generating three-dimensional geographical images of scenery which could be viewed by a pilot or crews based on view-point data sent from the head-motion tracker 23 which will be described later and data from the flight data interface 5, and an integrated view generator 13 for generating integrated views which are combination of three-dimensional view data of left and right images from the stereo-camera 2, obstacle data from the stereo-image recognition processor 11, geographical data on wide view from the geographical image generator 12 and data from the flight data interface based on the statuses instructed by the sight-axis switch 3 and display-mode switch 4 of the stereo camera 2.

[0023]

The stereo-image recognition processor 11 is provided with an image database 11a that stores several types of three-dimensional data for recognizing and displaying several types of obstacles, etc. The geographical image generator 12 is provided with a three-dimensional digital map 12a that stores wide-area geographical data obtained by aerial survey or from satellites.

[0024]

The integrated view displaying apparatus 20 is provided with a head-mount display (HMD) 21 to be mounted on a helmet of the pilot or crews and having a transparent-type display such as a transparent-type liquid-crystal display panel by which

a pilot or crews can view actual scenery through integrated views from the integrated view generator 13, a display adjuster 22 for adjusting intensity and contrast of integrated views, and transparency to the actual views on the HMD 21 so that the pilot or crews can observe the overlapped actual views and integrated views in a good condition, and the head-motion tracker 23 for tracking the head position and attitude of the pilot or crews to output view-point data of the pilot or crews.

[0025]

In the integrated view system 1 in the configuration as above, a pair of left and right images taken by the stereo-camera 2 during flight is sent to the integrated view generator 13 as three-dimensional images and also to the stereo-image recognition processor 11 for detecting forward obstacles. The stereo-image recognition processor 11 processes the left and right images from the stereo-camera 2 by stereo-matching processing to obtain correlation between the images, thus calculating distance data by triangular surveying based on parallax to the same object, the position of the stereo camera 2 and its parameter such as focal length.

[0026]

Data stored in the image database is accessed based on the distance and image data for recognizing obstacles, any objects that would block flight. The integrated view system 1 installed in aircraft, for example, helicopters that fly relatively low altitude recognizes structures such as pylons and skyscrapers or other aircraft, etc., in forward view during night flight. When the system 1 also recognizes high-voltage electrical power lines in the image data under recognition of pylons, it generates obstacle data that symbolizes or emphasizes the power lines and sends the data to the integrated view generator 13.

[0027]

The present invention therefore offers high safety flight or driving without determination of degree of risk of collision by comparing stored positional data such as longitude, latitude and altitude with actual flight data in three-dimensional digital map as the conventional arts. Accordingly, when the integrated view system recognizes pylons, high-voltage electrical power lines and skyscraper, etc., in forward view via the

stereo camera 2, it immediately warns the pilot of those structures as obstacles that could collide with so that the helicopter immediately takes an evasive action. Thus, the safety can be enhanced very effectively.

[0028]

The geographical image generator 12 performs coordinate-conversion of aircraft data such as speed, altitude and attitude and flight positional data input via the aircraft flight data interface 5 onto viewing points of the pilot or crews input from the head-motion tracker 23. The generator 12 further retrieves the converted data from the three-dimensional digital map 12a as three-dimensional geographical images which could be viewed by the pilot or crews and sent the three-dimensional images to the integrated view generator 13. The three-dimensional images are geographical data wider than actual scenery in forward view, for example, a row of mountains in the distance which will not be directly connected to safety against collision. These three-dimensional geographical image data can be seen as almost real scenes based on three-dimensional display generated by CG (computer graphics) with geographical data such as place names, lakes, loads and rivers if necessary.

[0029]

The three-dimensional geographical image data may be generated from images detected by a wide milli-wave radar instead of the three-dimensional digital map 12a.

[0030]

The integrated view generator 13 receives three-dimensional image data of left and right images taken by the stereo-camera 2 controlled by the sight-axis switch 3 and also the obstacle images generated by the stereo-image recognition processor 11. The generator 13 also receives wide peripheral geographical images generated by the geographical image generator 12. The integrated view generator 13 combines the obstacle and peripheral geographical images with image processing such as adjustments to resolution, intensity, contrast and color, and also edge-blending under the control of the display-mode switch 4, to generate natural images with no visible joints of combination as integrated view data. The integrated view generator 13 combines the integrated view data with flight data such as speed, altitude, position and attitude sent from the flight data interface 5 if

necessary, and sends them to the HMD 21. At high visibility such as a good weather, the stereo camera 2 may be turned off so that integrated view data not three-dimensional images of the stereo camera 2 but the obstacle data and other data, if necessary, are sent to the HMD 21.

[0031]

Fig. 2 illustrates viewing zones covered by the HMD 21 with the integrated view data processed as disclosed above. A viewing zone surrounded by a dashed line is used for displaying the forward view data with obstacle data from the stereo camera 2. Another viewing zone surrounded by a dotted line but outside the dashed line is used for displaying the wide-area view data of three-dimensional geographical images. The pilot or crews can see actual scenery from a cockpit 30 through windows overlapping with the integrated views while watching indicators on the cockpit, thus the pilot or crews can see to indicated data in addition to those displayed on the HMD 21.

[0032]

As disclosed above, the integrated view system 1 according to the present invention offers a pilot or crews with three-dimensional images almost real in perspective, altitude and speed based on left and right images taken by the stereo camera 2 even at a low visibility, which cannot be achieved by a single camera. The integrated view system 1 further processes the left and right images from the stereo camera 2 by stereo-image processing for image recognition using distance data to detect obstacles on or in the vicinity of flight rout and displays the obstacles as warning.

[0033]

The integrated view system 1 according to the present invention thus offers pseudo-visual flight even at low visibility to support a pilot for safe and sure flight in regular service or emergency. Three-D images may not be required at high visibility, however, detection of obstacles for warning by stereo-image recognition processing achieves further safe flight. Three-dimensional image display of forward views and obstacle detection/warning are performed by the stereo-camera 2 with no sensors for respective functions. The integrated view system 1 according to present invention thus can be structured as a reliable and light system at a low cost.

[0034]

[Effect of the Invention]

As disclosed above, the present invention offers crews on a vehicle with almost real pseudo views at high visibility like in a good whether even at low visibility for safe and sure flight or driving with detection of obstacles to the front.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 shows a block diagram of an integrated view system according to the present invention; and

[Fig. 2]

Fig. 2 illustrates displaying zones of the integrated view data.

[Description of the Reference Numerals]

1. Integrated view system
2. Stereo camera
10. Image combining apparatus
11. Stereo-image recognition processor
13. Integrated view generator
20. Integrated view displaying apparatus
21. Head-mount display

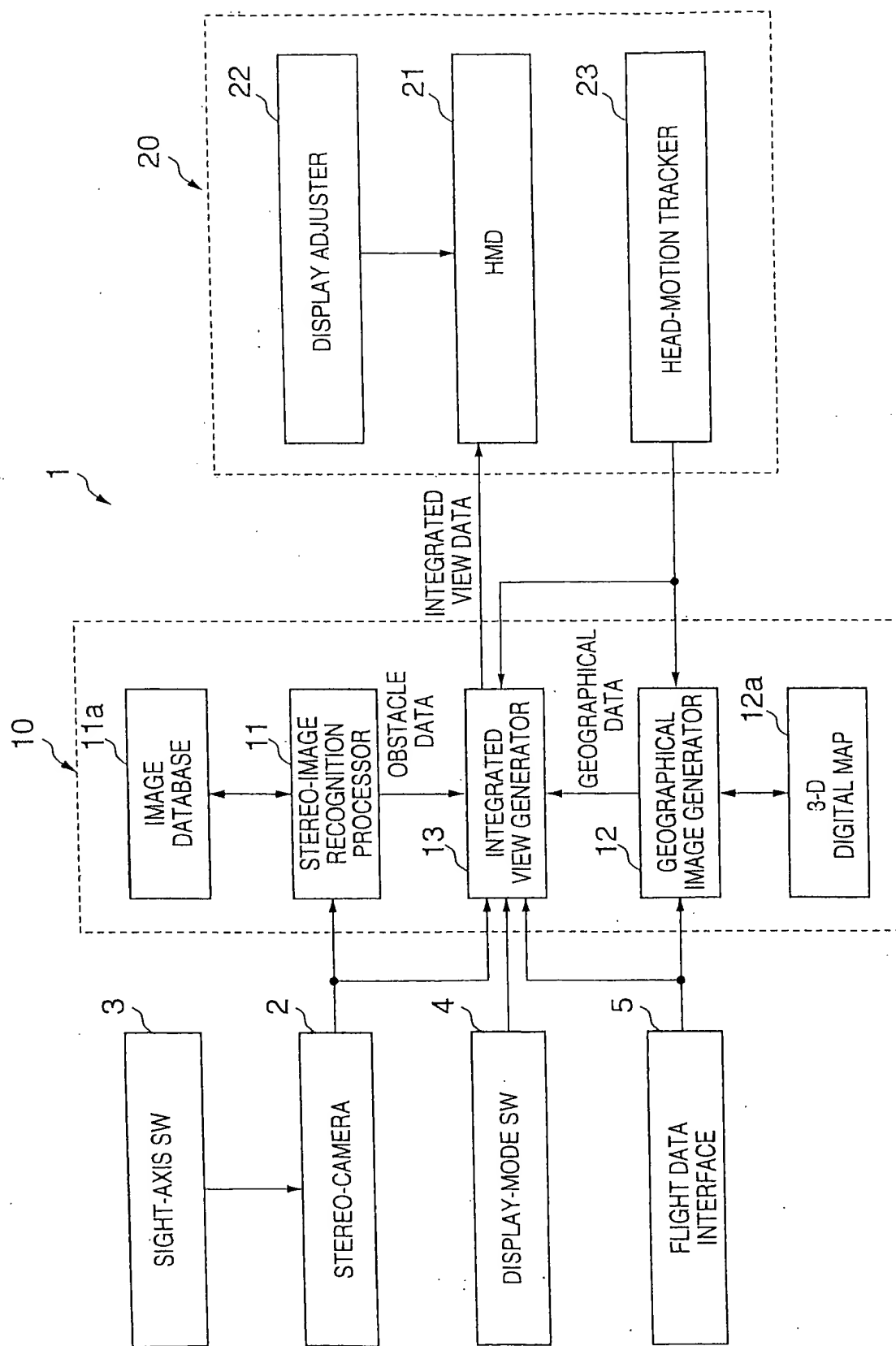


Fig. 1



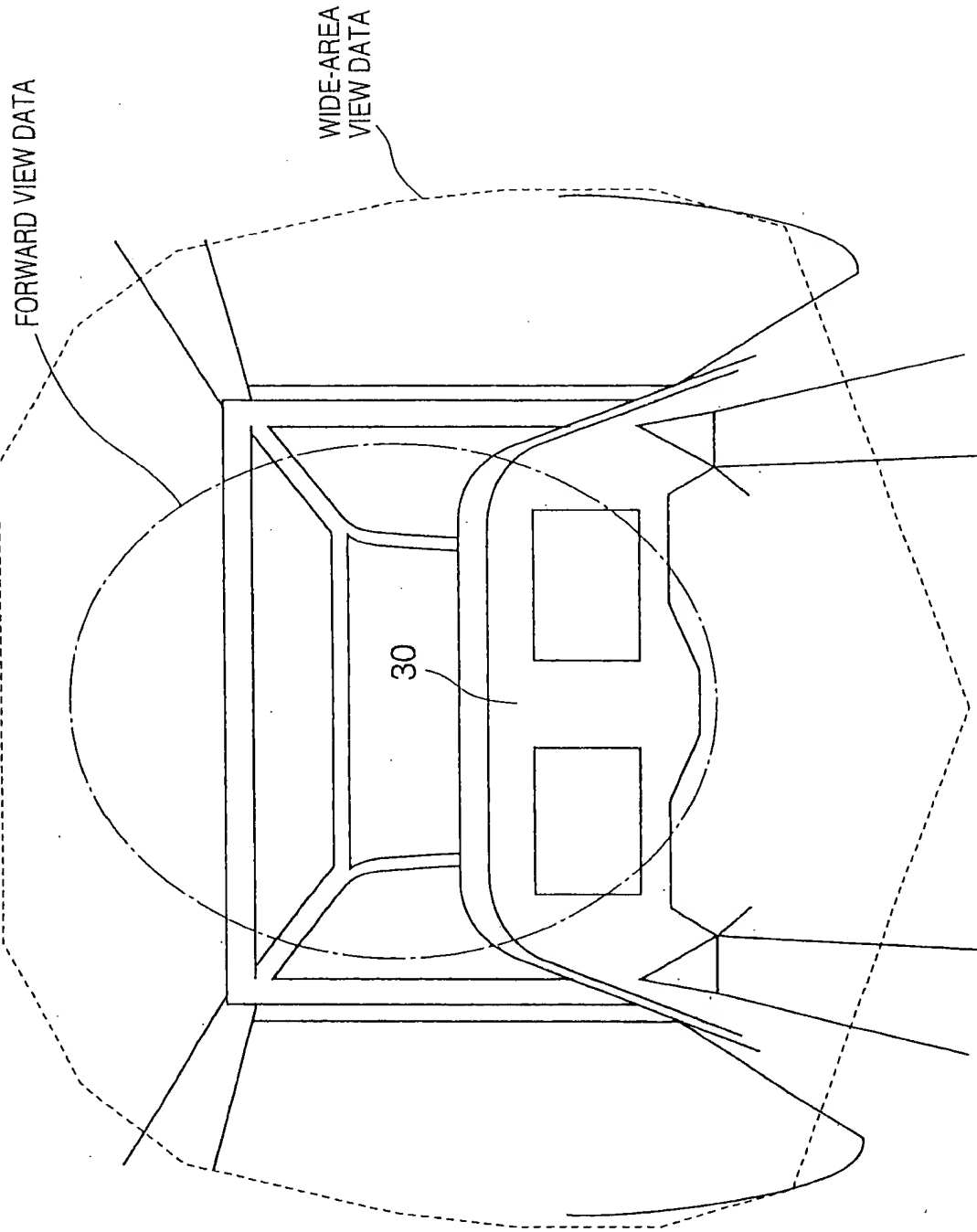


Fig. 2

[Document Type]    ABSTRACT

[Abstract]

[Object]

A purpose of the present invention is to provide an integrated view system that offers crews on a vehicle with almost real pseudo views at high visibility like in a good whether even at low visibility with detection of obstacles to the front for safe and sure flight or driving.

[Means for Solving the Problems]

A pair of left and right images taken by the stereo-camera 2 is sent to the integrated view generator 13 as three-dimensional images and also to the stereo-image recognition processor 11 for detecting forward obstacles. At the same time, the geographical image generator 12 generates wide peripheral geographical images as three-dimensional geographical data. The integrated view generator 13 generates natural integrated view data by the three-dimensional images and obstacle data, and peripheral geographical images. Further, the integrated view generator 13 combines the integrated view data with flight data such as speed, altitude, position and attitude sent from the flight data interface 5 and sends them to the HMD 21.

[Selected drawing]

Fig. 1